PATRIOT RENEWABLES
Canton Mountain Wind, LLC

Section 12
Stormwater Management

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Canton Mountain Wind, LLC

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12.0 STORMWATER MANAGEMENT PLAN

12.1 Overview

The Canton Mountain Wind Project (Project) is an eight-turbine, 22-megawatt (MW) wind energy generation project located in the municipality of Canton, Oxford County, Maine. The Project includes approximately 7,175 linear feet of gravel road improvement and temporary widening on Ludden Lane; 8,600 linear feet improvement and temporary widening on a private, unnamed logging road; and approximately 10,600 linear feet of new roads, including (i) a 3,425-foot-long access road to the ridgeline, (ii) an approximately 7,175-linear-foot ridgeline road that will connect the wind turbine tower foundations, and (iii) a 360-foot-long access road to the operations and maintenance (O&M) building. Along the ridgeline road, eight wind turbines and associated electrical collection infrastructure will be installed. The Project also includes a 3,500-square-foot O&M building, and an approximately 7,500-square-foot parking lot. All new impervious areas will be treated pursuant to the Maine Stormwater Management Law (38 M.R.S.A. § 420 et al. and Chapter 500 Rules). When construction of the Project is complete, the total impervious area will be 4.6 acres, and the total developed area will be 5.3 acres.

Power from the turbines will be collected in a 34.5-kilovolt (kV) underground collector line system buried within the ridgeline road work limits, which will transition to an aboveground transmission line approximately 3,425 feet down from where the access road meets the ridgeline road. From there it will continue aboveground roadside, mounted on wood poles, for approximately 1.59 miles to the intersection with the existing right-of-way built for the Saddleback Ridge Wind Project (Maine Department of Environmental Protection [Maine DEP] licenseL-25137-24-A-N/L-25137- TG-B-N). The proposed transmission line will travel an additional 1.1 miles south sharing a transmission right-of-way with the Saddleback Ridge Wind Project until it reaches Central Maine Power Company's (CMP) Ludden Lane Substation, which will connect the Project to the existing 115-kV regional transmission grid.

Because the Project consists primarily of linear features, it is regarded as a linear project pursuant to Maine's Stormwater Law. These linear features are required to meet 75 percent stormwater treatment as described in the General Standards. Turbine pads and the O&M building are not considered linear and are required to meet 95 percent stormwater treatment. Disturbed areas not considered part of permanent project facilities will be restored and revegetated following construction. The existing roads will be widened only temporarily for construction before being revegetated. The new access road to the ridge will be built 24 feet wide to allow access for construction equipment. The ridgeline road will be constructed at 32 feet wide to allow for the large construction equipment and cranes needed to assemble the turbines. In an effort to minimize project impacts, the access road and ridgeline road will be reduced to a final width of only 12 feet for operation of the Project, with the exception of periodic turnouts to allow for passing vehicles. The road base and cross sections will remain in place, but the temporary gravel road surfaces (12 feet and 20 feet wide, respectively) will be loamed and seeded and/or treated with an erosion control mulch to maintain these areas as vegetated meadow buffers. During operation of the Project, a crane or other heavy equipment may need to access the turbines for maintenance or repairs; however, if meadow buffer areas are disturbed during these maintenance activities, they will be restored following completion of the necessary repairs or maintenance.

The Project requires a Maine DEP Site Location of Development Act permit and is required to meet the Basic Standards, General Standards, and the Flooding Standard of the Maine Stormwater Law (38 M.R.S.A. § 420-D.1, *Standards*, and Chapter 500-Rules).

Presently, the project area is wooded and used as commercial timber land. Adjacent properties are generally undeveloped and used primarily for commercial timber harvesting operations, like the project site. Disturbed areas, excluding permanent facilities, will be reseeded and revegetated in a manner that will allow these areas to revert to natural conditions (refer to Section 14 – Basic Standards). Although construction of the facility will involve the disturbance of approximately 33.4 acres of land, 5.3 acres of new developed area will remain following construction, of which 4.6 acres will be impervious area.

This site is not located in the direct watershed of an Urban Impaired Stream listed in Chapter 502, Appendix B. The project area drains to Ridley Brook and Ludden Brook, which both drain to the Androscoggin River, and parts of the project area also drain directly to the Androscoggin River (see Figure 12-1). Eventually, the Androscoggin River flows into the Atlantic Ocean.

Canton Mountain Wind, LLC (CMW) is proposing low-impact design methods using natural buffers to treat stormwater runoff from the Project. These natural buffers will convey treated stormwater runoff from impervious areas as sheet flow, similar to existing site conditions. Stormwater calculations for the project site demonstrate that there will be an insignificant increase in peak flow rates or runoff volume from the Project. With the exception of the underdrained soil filter near the O&M building (see Section 12.9), stormwater detention facilities are not warranted for the Project since there will be insignificant increases in peak flows associated with storm events. A small portion of Ludden Lane is located within the 100-year flood plain; however, the upgrading of this section of Ludden Lane will not result in a net decrease in flood storage capacity. As a result, CMW is requesting a waiver from the Flooding Standard pursuant to Chapter 500(4)(E)(2).

Each natural buffer area or other stormwater feature was designed in relation to the affected area to be treated. These features were sized using the proposed site conditions and amount of impervious area draining to each buffer, based on *Stormwater Management for Maine* and Chapter 500 buffer standards. Attachment 12-1 includes the HydroCAD® stormwater calculation reports, including modeling assumptions, sub-catchment areas, flow paths, drainage reaches, etc. Attachment 12-2 includes the Pre- and Post-development Drainage Plans. Runoff calculations were performed for a 25-year storm event for the existing and developed conditions.

12.2 Methodology

Natural Resources Conservation Service (NRCS) maps were used to obtain regional rainfall data. The Soil Conservation Services' (SCS) Technical Release (TR)-20 computer modeling method was used within HydroCAD® 9.10 to perform hydrologic and hydraulic calculations. This method accounts for existing soils and land use, topography, vegetative cover and proposed land use. The conditions of the project site were evaluated to determine pre-development and post-development peak stormwater flows, drainage patterns, flow velocities, and other attributes of the site. These conditions were analyzed using data for a Type III, 24-hour storm distribution, with a frequency of occurrence of 25 years. Rainfall amounts for this storm are 4.8 inches. The hydrologic calculations can be found in Attachment 12-1.

Figure 12-1. Watershed Areas

12.3 Topography and Vegetation

The majority of the project area is comprised of undeveloped forest land and commercial forestry operations with moderately steep to steep mountainside slopes. Elevations generally range between 490 feet above sea level in the vicinity of the O&M building to 1,600 feet above sea level in the vicinity of the highest turbine site located along the ridgeline. Slopes range from 0 percent to 60 percent but mostly occur at 30 percent or less in the vicinity of the ridgeline access road and turbine sites. Forest stands in the project area are typical of lands subject to commercial forestry operations. The project area was assumed to be in good condition for the purpose of runoff calculations.

Wetlands, state and federal jurisdictional waterbodies, and numerous non-jurisdictional drainages were field delineated and mapped in the project vicinity and impacts to these resources were avoided and minimized where possible.

12.4 Site Soils

Site-specific soils mapping, in conformance with Class B (High Intensity), Class D (Modified) and Class L (Linear) standards, was performed for the project site (see Section 11 of this application). According to these surveys, the project site primarily includes forested side slopes and mountain top ridges. Soil landforms generally consist of loam and sandy loam soils derived from glacial till. The tops of the mountain and ridgelines are generally bedrock controlled, and consequently exhibit shallow to bedrock soil conditions. The side slopes tend to be comprised of deeper soils (i.e., +40 inches in depth), which are loam to sandy loam textured soils generally derived from glacial till sediments. These soils commonly exhibit a firm substratum that produces a perched groundwater table. The soil mapping units produced as a result of this soil survey were overlaid on the engineering drawings and used for the stormwater analysis and design. For stormwater calculation purposes, the soils were grouped by Hydrologic Soils Group (HSG), drainage classifications defined by the NRCS. These groups are shown on the drainage plans in Attachment 12-2. The soils on the site are predominantly HSG C and D. The ridgeline is mostly HSG C and D soils, while the side slopes and lower elevation areas are generally HSG C soils.

12.5 Stormwater Quality Best Management Practices

The Project was designed to comply with the requirements of Maine DEP's best management practices (BMPs) for stormwater, identified in the *Stormwater Management for Maine* manual, published by the Maine DEP in January 2006. The project design incorporates many of the BMPs contained in this manual, including level spreaders, ditch turnouts, and stone berms. The design also integrates features geared towards minimizing the effects on ground and surface water flow.

The General Standards, Section 4(B)(2) of the Chapter 500 Rules require that runoff from no less than 95 percent of the impervious area and no less than 80 percent of the developed area that is impervious or landscaped is controlled and treated using accredited BMPs. The linear features of the Project – the roads – in accordance with Section 4(B)(3)(c) of the General Standards will require treatment for no less than 75 percent of the runoff volume from the impervious area and no less than 50 percent of the developed area that is impervious or landscaped. The turbine pads and O&M building are not considered linear and are required to meet 95 percent stormwater treatment. This Project achieves treatment for 100 percent of all impervious non-linear areas and over 77 percent of impervious linear features (see Attachment 12-1).

The existing utility corridor would include only negligible new impervious areas associated with the additional proposed power poles, and the roadside transmission line will be built and operated in compliance with the criteria specified in Section 4(B)(3)(d) of the General Standards. Consequently, the electric transmission line portion of the Project is not subject to the Chapter 500 General Standards. In addition, the utility corridor will be maintained in accordance with Maine DEP's Chapter 375, *Minimum Performance Standards for Electric Utility Corridors*. CMW has prepared a Post-Construction Vegetation Management Plan (Attachment 10-1, Section 10 of this application) that will be reviewed by Maine DEP as part of this permit application.

12.6 Pre-Development Conditions

With the exception of Ludden Lane, logging roads and associated landings, the project site is currently wooded and undeveloped, though used for commercial timber harvest. Like a typical logged forest, it is vegetated with a mix of mature deciduous and coniferous trees, well-established medium and young trees, and thick brush, grasses and meadow vegetation. Stormwater runoff from the existing project site is grouped into three large subcatchments, covering approximately 2,978 acres, as described below and shown on Figure 12-1.

Subcatchment A is located east of the ridgeline and access road. This drainage area includes approximately 530 acres of wooded mountainside controlled by CMW. The area contains primarily HSG C and D soils. There are a few existing dirt roads, but otherwise the area is undeveloped. The runoff curve number for this subcatchment is 70 with a 25-year storm peak flow rate of 530 cubic feet per second (cfs).

Subcatchment B is located west of the ridgeline. This drainage area includes approximately 2,441 acres of wooded mountainside controlled by CMW. The area contains primarily HSG C soils with smaller areas of D soils at the highest elevations. There are a few existing dirt roads in this drainage area including Ludden Lane, but otherwise the area is undeveloped. The runoff curve number for this subcatchment is 70 with a 25-year storm peak flow rate of 2,441 cfs.

Subcatchment C is located southwest of Canton Mountain, adjacent to Ludden Lane. This drainage area includes approximately 6.8 acres of wooded mountainside controlled by CMW. The area contains primarily C soils. There are a few existing dirt roads, but otherwise the area is undeveloped. The runoff curve number for this subcatchment is 70 with a 25-year storm peak flow rate of 6.8 cfs.

Refer to Attachments 12-1 and 12-2 for a further description of the various subcatchment areas.

12.7 Stormwater Calculations and Results

A post-development drainage analysis was performed to determine if the Project would increase runoff from the site and, therefore, require stormwater detention for a 25-year storm event.

Hydrologic soil group areas were identified for each watershed based upon the soil surveys performed by Albert Frick Associates, Inc. and detailed in Section 11 of this application. The most distant hydraulic travel length was identified for each of the three watersheds. Length and width of all existing roadways within the watershed boundaries were estimated and assumed to have a runoff curve number (RCN) of 89, assuming gravel roadways (HSG C). All wooded areas were assumed to be in good condition.

Stormwater calculations assumed 12-foot-wide impervious roads, a 50- by 80-foot area for each gravel crane pad surrounding turbine foundations, an approximately 1,135-square-foot concrete area for each turbine base, and a 3,500-square-foot O&M building with a 7,500-square-foot parking lot. The post-development watershed areas are the same as the pre-development watershed areas. The time of concentration was assumed to remain the same in both pre- and post-development. Results of the stormwater runoff calculations are shown in Table 12-1.

Table 12-1. Existing and Post-Development Peak Flow Rates and Runoff Volumes

	Watershed A	Watershed B	Watershed C
Watershed Area within Project Area (acres)	530	2,441	6.8
Increase in Impervious Area (acres)	2.30	2.07	0.38
Increase in Impervious Area (% of Total Watershed)	0.4%	0.1%	5.6%
Existing Peak Flow Rate (cubic feet per second)	530	2,441	6.8
Existing Runoff Volume (acre-feet)	75	348	1
Post-Development Peak Flow Rate (cubic feet per second)	530	2,441	6.8
Post-Development Runoff Volume (acre-feet)	75	348	1

12.8 Post-Development Conditions

The Project's stormwater management low-impact development system was designed to mitigate the impacts of the proposed gravel roadways while maintaining simplicity in the design. This simplicity is important because it requires a minimum amount of maintenance to ensure its proper function, which in turn provides a higher probability of long-term effectiveness.

In general, there will be very little change in the runoff characteristics of the site after completion of the Project. Stormwater runoff of upgradient undisturbed areas will be intercepted by either a riprap ditch or riprap shoulder. This runoff will be encouraged to infiltrate through the blasted rock sub-base of the road. During larger storms, the stormwater is directed to culverts that outlet to level spreaders. The level spreaders then redistribute the water to resemble natural sheet flow. Pre-developed mountain side slopes have an approximate grade of 20 to 60 percent; however, the proposed roadside ditches will have a maximum slope of only 13 percent, enabling them to slow the upstream flow, thereby decreasing the runoff for areas intercepted by the roadway. While there will be a slight increase in overall runoff due to the roadway, it will generally be mitigated by this decrease in upstream runoff.

No significant changes in runoff are expected following development of the site. This is primarily due to the impervious area proposed in each subcatchment being a relatively small percentage of the whole. For example, in Subcatchment B, 2.07 acres of impervious surface are proposed, but that represents less than 0.1 percent of the 2,441 acres of the watershed within the project area, as shown in Table 12-1.

Much of the project site has thin soils over bedrock, which are typically conducive to producing large volumes of stormwater runoff. Because large mountainside watersheds already have large volumes of runoff, the increase in runoff due to construction of gravel roadways and turbine foundations would be minimal. Both the relatively small increase in impervious area and the minimal change in runoff volumes following construction contribute to insignificant changes in runoff characteristics post-construction. The

HydroCAD® calculations in Attachment 12-1 also demonstrate that no significant changes to the rate or volume of runoff are anticipated from post-development site conditions.

Low-Impact Development (LID) is the general term used to describe a design strategy that minimizes disturbance and aims to maintain the pre-development hydrologic regime through the use of design techniques and BMPs. A combination of hydrologic functions such as runoff storage, infiltration, groundwater recharge, vegetation and buffer filtration, time of concentration, and sheet flow are preserved through the use of stormwater management BMPs, buffers, reduction of impervious surfaces, conservation of natural areas and control of runoff close to the source.

Traditionally, the impact of development to a watershed is measured in terms of increases in peak flow rates and changes in flow regimes. Conventional stormwater management methods direct all stormwater to channel-like flow. Through the use of ditches, storm drains, and other "end-of-pipe" controls, the stormwater is carried to detention ponds and other point sources of discharge as quickly as possible. The end-of-pipe system is designed for the larger and more infrequent events such as the 10- and 25-year storms. Such a system is not designed to manage smaller, more frequent events such as the 1- and 2-year events that make up 90 to 95 percent of all rainfall events. As a result, these smaller, more frequent storms over-drain a site managed by conventional stormwater practices and eventually erode natural streams, causing downstream pollution due to the rapidly transported pollutants. In contrast to conventional stormwater management methods, LID methods control stormwater at the point of collection. Instead of channeling the water to a detention pond, stormwater runoff is discharged in a more natural condition, as sheet flow. The project objectives are to minimize disturbance and maintain a pre-development hydrology regime. The Project will replicate existing runoff conditions and drainage patterns through the use of a LID system, instead of using more conventional end-of-pipe systems.

The provisions of the Maine Stormwater Law and Site Location of Development Act typically require stormwater detention practices in order to meet the flooding standard required for large projects such as this. Results of these analyses indicate that the Project will produce little or no increase in peak flow rates; therefore, CMW is requesting a waiver of the Flooding Standard per the General Standards, Section 4(E)(2)(b) of the Chapter 500 Rules.

12.9 Stormwater Quantity Management

The primary concept of the Project's stormwater management system is to minimize the amount of water traveling over the newly created roadway. This will be accomplished by first intercepting the surface water flow on the uphill side of the roadway with a ditch that will be constructed along the upper edge of the road. Water will flow from the ditch through a culvert system, allowing the water to pass under the roadway. At the outlet of the culverts, level spreader systems will be provided to allow the flow to be disbursed downstream. In addition, at the naturally-occurring low points in the roadway where a fill is present, a stone and geotextile filtering system (commonly referred to as a rock sandwich) will be installed under the roadway sub-base to allow upgradient ground and surface waters to travel under the roadway unimpeded by the new construction. Similar to the rock sandwich, a rock maki section will be used in cut sections showing high water table or high runoff potential. In these sections, an additional foot of stone will be placed under the sub-base of the road and connected to the ditch's sub-base. This extra layer of stone will encourage infiltration of the groundwater and surface water under the road. The rock sandwich and rock maki are examples of LID systems that take the focus away from concentrated flow.

These two systems have the ability to deal with smaller runoff more naturally, but they are also capable of handling larger storm events. This system will maintain flows as close to sheet flow as possible.

Frequent culverts, level spreaders, buffers and other erosion control measures will be used throughout the Project in order to control runoff and erosion. Culvert sizes, locations, and elevations are specified on the design drawings (Exhibit 1); however, final culvert locations may need to be adjusted slightly in the field based on site-specific conditions. The final locations and elevations of culverts will be noted and included on the as-built plans for the Project. Culvert sizing calculations and a Schedule of Proposed Culverts can be found in Attachments 12-3 and 12-4, respectively.

Runoff from the final gravel roadway system will be directed through an artificially created meadow buffer. The artificial meadow buffer will be 12 feet wide for the access road and 20 feet wide for the ridgeline road. The runoff will then travel through a forested buffer at least 35 feet wide, with the upslope edges of these buffers beginning at the clearing limits or further downslope (see Exhibit 1). Buffers outside of the clearing limits will be protected with deed restrictions. Meadow buffers within the original road widths will not be deed restricted as a crane may be needed at some point during the operation of the Project; any meadow buffers within the original road widths that are disturbed by a crane will be restored after the crane leaves the project site. A sample deed restriction for forested buffers can be found in Attachment 12-5. Buffers were sized using the *Stormwater Management for Maine* manual and in consultation with Maine DEP.

Distribution berms and treatment berms will also be implemented in steeper buffer areas to slow flows and guarantee proper treatment. The distribution and treatment berms will be composed of an erosion control mix material. The distribution berms will be placed at the upslope end of specified buffers to ensure that stormwater will enter the buffers in sheet flow and gain maximum treatment. The treatment berms will be placed at the downslope end of specified buffers to slow flows and maintain sheet flow. This filtering system will also remove sediment before the surface water travels downstream.

Runoff from the O&M building pad will be treated by a vegetated, underdrained soil filter system where the runoff is captured and retained, then passed through a filter bed comprised of a specific soil media. This soil filter will have a mixture of silty sand and organic matter to achieve the highest removal rates. Once through the soil media, the runoff is collected in a perforated underdrain pipe and discharged downstream. The filter structure provides for the slow release of smaller storm events, minimizing channel erosion, and cooling the discharge. Calculations for the underdrained soil filter can be found in Attachment 12-6.

Results of the stormwater runoff calculations are shown in Table 12-1. Complete printouts for stormwater data, calculations, modeling assumptions and HydroCAD® reports for the pre-development and post-development conditions can be found in Attachment 12-1. The peak flow rates and runoff volumes from the pre-development site conditions are not significantly affected by the proposed development as indicated by the post-development calculations. Based on these results, no flooding or adverse stormwater-related impacts are anticipated in association with development of the site. Although the project will add impervious area, the overall runoff curve number remains the same for the pre-development and post-development conditions of the site. The increase in peak flow post-development will be insignificant for all storm events. Therefore, stormwater mitigation for water quantity is not required for this Project, per the *Stormwater Management for Maine* manual.

12.10 Erosion and Sedimentation Control

Erosion and sedimentation control plans were prepared for the Project and are incorporated into the civil design plans (Exhibit 1). During construction, a variety of stabilization measures will be used to prevent sedimentation from soils due to wind and water action. The locations and details of proposed stabilization measures are illustrated in the drawings in Exhibit 1. All erosion control and stabilization measures have been designed to adequately address the requirements of the basic stabilization standards as defined in Chapter 500, *Stormwater Management Rules*. See Section 14, Basic Standards, of this application for a detailed description of proposed erosion and sedimentation control practices.

12.11 Water Quality

Since the project is primarily considered a linear project. A minimum of 75% percent of the runoff volume from the impervious area and no less than 50 percent of the developed area that is impervious or landscaped must be treated. The project achieves 75.85% water quality treatment with the use of artificially created meadow buffers and 35' wide forested buffers beginning at the clearing limits or further downslope. The turbine pads and O&M building are not considered linear and are required to meet 95 percent stormwater treatment. This Project achieves treatment for 100 percent of all impervious non-linear areas.

12.12 Conclusions

The Project was designed to comply with the Basic Standards and General Standards of Maine's Stormwater Law. The post-development drainage analysis shows a negligible increase in runoff volume for a 25-year storm event. A series of BMPs and buffers have been incorporated into the design to replicate pre-development conditions. The Project's post-development drainage analysis shows no increase in peak flow rates; therefore, CMW is requesting a waiver from the Flooding Standard. The proposed LID BMPs, natural buffers, and underdrained soil filter (designed to accommodate runoff from the O&M area) will provide sufficient stormwater quantity and quality management without producing adverse impacts. A schedule of the proposed Project BMPs is provided in Attachment 12-7. The proposed stormwater management system will be constructed and maintained in accordance with Maine DEP Standards and is designed to closely replicate pre-development stormwater conditions at the site and, therefore, will not result in flooding or degradation of existing water quality in the project area.

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Attachment 12-1
HydroCAD® Calculations

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Attachment 12-2
Pre-development and Post-development Stormwater Drainage Basins

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Attachment 12-3
Culvert Sizing Calculations and Related HydroCAD® Reports

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Attachment 12-4
Schedule of Proposed Culverts

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Attachment 12-5
Sample Declaration of Restrictions for Forested Buffers

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Attachment 12-6
Underdrained Soil Filter Calculations

Attachment 12-7
Schedule of Stormwater Best Management Practices